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ABSTRACT

This paper describes a three-year project that has created on-line lessons and activities on math and aeronautics aimed at improving the education and aeronautics-related career options for children with physical disabilities. It has developed a specialized program, drawing from existing curricula, available materials and assistive technology, which uses the Internet to support an interactive education experience. The project targets schools nationally with students in grades 4 through 7 and has been useful to students in general education as well as special education settings. The project was based on two issues: an awareness that current mathematics curricula are highly reliant on students' ability to use manipulables, which leaves children with disabilities that affect their ability to manipulate objects at an academic disadvantage, and the realization that children with physical disabilities may not consider or be prepared for possible careers in aeronautics. The paper describes the goals of the project, the rationale behind using the Internet as a medium for providing aeronautics-based math activities, the project's timeframe, project resources, the curriculum design, the mathematical and aeronautical content that is covered, how the content was taught, and the accessibility of the World Wide Web pages. (CR)

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TEACHING MATHEMATICS TO STUDENTS WITH PHYSICAL DISABILITIES USING THE WORLD WIDE WEB: THE PLANEMATH PROGRAM

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INTRODUCTION

InfoUse is running a three year project entitled "An Internet-Based Curriculum on Math and Aeronautics for 4th -7th Grade Children with Physical Disabilities" with funding through a cooperative agreement with the National Aeronautics and Space Administration (NASA). NASA's award, which is administered through the High Performance Computing and Communications (HPCC) Office as part of NASA's Laerning Technologies Progam (LTP) program and NASA-Ames Research Facility at Moffett Field, was given as one of eight such awards for developing new ways of teaching science, mathematics, engineering, and aeronautics through developing new Internet-based information technologies.

This project has created on-line lessons and activities on math and aeronautics aimed at improving education and career options for children with physical disabilities. This project has developed a specialized program, drawing from existing curricula, available materials and assistive technology, and using the Internet to support an interactive education experience. The project targets schools nationally with 4-7th grade students. The on-line lessons and activities have been useful to students in mainstream general education as well as special education settings.

The genesis of this project is based around two issues. The first issue came from an awareness that, around the 4th grade, current mathematics curricula are highly reliant on students' ability to use manipulables such as paper and pencil, calculators, or three-dimensional geometric models. Children with disabilities that affect their ability to manipulate objects (cerebral palsy, muscular dystrophy, specific hand/arm conditions, etc.) and who therefore find it difficult or impossible to use such manipulables are clearly at an academic disadvantage. The second issue came from the realization that physically disabled children may not consider or be prepared for career possibilities in aeronautics or the importance of mathematics in pursuing these careers. The Internet, with its multimedia and communication capabilities, holds great potential for allowing these issues to be addressed.

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PROJECT MISSION AND GOALS

The stated mission of this project is "To stimulate and motivate students with physical disabilities in grades 4-7 to pursue aeronautics-related careers via the development and delivery of accessible math

education materials on the Internet." From this mission, we developed four goals:

- 1. Accessibility - Improve access to mathematics and aeronautics curricula materials for 4th-7th graders with physical disabilities.
- 2. Math Proficiency - Improve mathematics proficiency outcomes among 4th-7th grade students with physical disabilities.
- 3. Aeronautics Careers - Inspire and motivate students with physical disabilities to pursue aeronautics-related careers.
- 4. Innovative Use of Technology - Increase access to, and use of, digital communication and multimedia technology among children with physical disabilities.

PRODUCT

The World Wide Web site at www.planemath.com contains lessons and provides mathematical exercises using examples from aeronautics that are maximally accessible by children with physical disabilities. The activities are based on national mathematics standards and aeronautic content guidelines. The Web site also contains "help" information, information for teachers/parents, opportunities for users to find out more about aeronautics from experts/role models, and links to other related Web sites in mathematics, disabilities, and aeronautics. The target age level for year 1 is 4th grade, for year 2 is 5th grade and for year 3 is 6th and 7th grades.

PROJECT RATIONALE

The Internet offers advantages and disadvantages as a medium for providing aeronautics-based math activities. We have re-examined the advantages to provide a rationale for the structure of the activities within this project to guide the design process.

Internet advantages:

- computer use is motivating, non-threatening and self-paced;
- Internet lessons are available to students anywhere there is a computer on-line;
- on-line use provides immediate access to an infinite and dynamic amount of information and resources from all over the world;
- specificity of information received is unmatched through other resources;
- on-line use extends a student's understanding and experience by providing interactive communication and sharing with students all over the world;
- possible cost benefits to Internet delivery.

In order for this project to appeal to classroom teachers and students, the inherent limitations of the Internet were identified and addressed. These limitations include:

- interactive capability within Hypertext Markup Language (HTML);
- activities that could be better addressed (based on best instructional practices) through CD-ROM or other software formats;
- realistic amount of time each classroom or group of students will spend on-line based on financial and classroom management restraints.
- accessibility issues

Technology is a tool for educating students. It is a means to an end, not an end in itself. Technology is best used as a tool for providing information to students when it can't be done in a better way. Effective use of the Internet to deliver aeronautics-based math activities has been achieved by incorporating the advantages of Internet use into the design.

TIMEFRAME

In the first year, the project established Internet access at school sites while designing and installing fourth grade level World Wide Web-based and instructional lessons. The lessons, written in HTML, are competency-based, with learning goals in math, aeronautics, and in the use of the Internet as a learning resource. The second year expanded the curriculum to fifth grade level mathematics, delivering additional lessons to the user site through Shockwave movies for interactive, real-time learning on the Internet. The third year has created curriculum-based materials for 6th and 7th grade level mathematics, accommodated advances in assistive technology, and evaluated the changes in interest level of students using the website.

PROJECT RESOURCES

While the project draws on the proven multimedia, accessibility, and education skills of staff at InfoUse, the project has a variety of resources. The Center for Accessible Technology, an Alliance for Technology Access (ATA) site in Berkeley, California is participating in curriculum research, accessibility issues and activity design. California State Polytechnic University, Pomona is providing Internet server access, demonstrations and presentations, and hosting teacher groups. Kinko's and Sprint have donated the use of their 300 nationwide videoconference sites for wide spread teacher training. More than a dozen software vendors and publishers have donated software for participating schools. An expert advisory panel of teachers, administrators, and individuals with specific expertise in math, aeronautics, disability, and Internet provides feedback to the project at various stages during the project.

CURRICULUM DESIGN

Research into classical and non-classical approaches to teaching math and interviews with teachers, administrators and experts in math curricula revealed the following list of educational approaches and content needs for students to be served in this project.

Approaches to project curricula:

- Outcome-based education
- An active role for students in their learning
- Use of careers and role models as goals to learning
- Cooperative work/Team or Peer Teaching (e.g., semester-long group investigation and group problem solving)
- Use real-world experiences to teach math (e.g., exploration, discussion and activities that mirror the mathematical problems encountered by pilots)
- Multi-cultural math treatments
- Appropriate presentations of persons with disabilities, females and males, and people of various

ethnicities and races.
- The program should augment existing learning materials, not be a comprehensive mathematics curriculum.

CONTENT

To ensure that the program followed the approach outlined above, we selected topics for inclusion into the program that are consistent with current educational practices and standards. These topics are presented in ways that are meaningful to a range of learners in today's classrooms. The National Council of Teachers of Mathematics (NCTM) Standards and state mathematics frameworks provided the mathematics content which needed to be covered; national aeronautics curricula were reviewed for age-appropriate content that could be taught with mathematical concepts.

Math content covered includes:

- Estimation;
- Measurement;
- Number sense and numeration;
- Whole number computation;
- Whole number operations;
- Geometry;
- Statistics and probability;
- Patterns and relationships;
- and Fractions and decimals.

Aeronautical content to be covered includes:

- History of Aerospace;
- Kinds and uses of Aircraft;
- Parts of An Airplane;
- Why Airplanes Fly;
- Weather;
- Instruments and Navigation;
- and Airports.

TEACHING THE CONTENT

Using the NCTM standards, the following list of ways to teach the content was assembled. Data collection: students will be involved in developing and implementing plans for collecting and analyzing data to answer questions, including concepts of mean, median, mode, and range. (The graphics capabilities of computers in general and the Internet in particular are ideal for generating teaching materials in this area.) Shapes: students will identify shapes, manipulate them in spatial relationships, and develop visualization skills, including understanding of perspective. Patterns: students will begin to discover patterns in their data, and can then make predictions and form hypotheses for other variables. Multiplication and Division: students will have opportunities for practicing these math facts in the context of solving questions within activities. Area and Perimeter: students will grow to understand the relationship between area and perimeter, and experiment with links to multiplication and division, and two-dimensional shapes. Fractions and Decimals: students will be able to practice working with fractions and decimals through pattern and shape. Grids and Graphs: students will display their data, hypotheses, and results in a variety of ways using grids and graphs. Patterns and relationships will

become obvious through these displays. Careers: teaching aeronautics for 4th grade children included the coordination of career information with the aeronautical concepts.

ACCESSIBILITY

Web pages can be made accessible in three ways: Web pages can be designed for optimal use, users can set specific preferences within browsers, and browsers themselves can be made more accessible. The project established criteria for, and is a model for, the design of World Wide Web pages with accessibility issues, needs, and equipment in mind. Of particular emphasis are consistent placement of hot links, parallel pages of text-only (no graphics), and non-scrolling pages. Browser preferences allow accessibility through font, color, and page size adjustment.

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